

WHAT IS CLAIMED IS:

1           1.     A pattern-center determination apparatus for  
2     determining a pattern center of a fingerprint-like pattern,  
3     which is formed with a number of pattern curves, said  
4     apparatus comprising:

5           an auxiliary-line generation section for generating  
6     two or more auxiliary lines extending continuously from an  
7     outer circumference side one of the pattern curves of the  
8     fingerprint-like pattern toward an inner circumference side  
9     one of the pattern curves so that each of the two or more  
10    auxiliary lines intersects each of the pattern curves  
11    perpendicularly or substantially perpendicularly; and

12          a pattern-center determination section for  
13    determining the pattern center based on one or more  
14    intersecting points of the two or more auxiliary lines  
15    generated by said auxiliary-line generation section.

1           2.     A pattern-center determination apparatus as  
2     claimed in claim 1, wherein said auxiliary-line generation  
3     section is operable to generate two auxiliary lines, and said  
4     pattern-center determination section is operable to  
5     determine an intersecting point of the two auxiliary lines  
6     generated by said auxiliary-line generation section as the  
7     pattern center.

1           3.     A pattern-center determination apparatus as

2 claimed in claim 1, wherein said pattern-center  
3 determination section includes an auxiliary-line-  
4 intersecting-point calculation section for calculating one  
5 or more intersecting points of the two or more auxiliary lines  
6 generated by said auxiliary-line generation section, and a  
7 most-crowded-point calculation section for calculating a  
8 most crowded point, at which the intersecting points  
9 calculated by said auxiliary-line-intersecting-point  
10 calculation section are most crowded, so as to determine the  
11 calculated most crowded point as the pattern center.

1 4. A pattern-center determination apparatus as  
2 claimed in claim 1, wherein said auxiliary-line generation  
3 section includes:  
4 a start-point setting section for setting an arbitrary  
5 point of the fingerprint-like pattern as a start point;  
6 a reference-circle generation section for generating  
7 a reference circle of a predetermined radius centered at the  
8 start point set by said start-point setting section;  
9 a reference-circle-intersecting-point calculation  
10 section for calculating intersecting points of the reference  
11 circle generated by said reference-circle generation section  
12 and the pattern curves of the fingerprint-like pattern;  
13 an intersecting-point extraction section for  
14 extracting those two of the intersecting points calculated  
15 by said reference-circle-intersecting-point calculation  
16 section which satisfy a predetermined condition;

17 an end-point calculation section for calculating a  
18 middle point of the two intersecting points extracted by said  
19 intersecting-point extraction section as an end point; and  
20 a line-segment generation section for generating a  
21 line segment interconnecting the start point set by said  
22 start-point setting section and the end point calculated by  
23 said end-point calculation section;  
24 wherein said start-point setting section is operable  
25 to set the end point as a new start point so that said  
26 reference-circle generation section, said reference-  
27 circle-intersecting-point calculation section, said  
28 intersecting-point extraction section, said end-point  
29 calculation section and said line-segment generation section  
30 repeatedly generate a new line segment, thereby generating  
31 the auxiliary line as a number of successive line segments.

1 5. A pattern-center determination apparatus as  
2 claimed in claim 2, wherein said auxiliary-line generation  
3 section includes:

4 a start-point setting section for setting an arbitrary  
5 point of the fingerprint-like pattern as a start point;

6 a reference-circle generation section for generating  
7 a reference circle of a predetermined radius centered at the  
8 start point set by said start-point setting section;

9 a reference-circle-intersecting-point calculation  
10 section for calculating intersecting points of the reference  
11 circle generated by said reference-circle generation section

12 and the pattern curves of the fingerprint-like pattern;  
13 an intersecting-point extraction section for  
14 extracting those two of the intersecting points calculated  
15 by said reference-circle-intersecting-point calculation  
16 section which satisfy a predetermined condition;  
17 an end-point calculation section for calculating a  
18 middle point of the two intersecting points extracted by said  
19 intersecting-point extraction section as an end point; and  
20 a line-segment generation section for generating a  
21 line segment interconnecting the start point set by said  
22 start-point setting section and the end point calculated by  
23 said end-point calculation section;  
24 wherein said start-point setting section is operable  
25 to set the end point as a new start point so that said  
26 reference-circle generation section, said reference-  
27 circle-intersecting-point calculation section, said  
28 intersecting-point extraction section, said end-point  
29 calculation section and said line-segment generation section  
30 repeatedly generate a new line segment, thereby generating  
31 the auxiliary line as a number of successive line segments.

1 6. A pattern-center determination apparatus as  
2 claimed in claim 3, wherein said auxiliary-line generation  
3 section includes:

4 a start-point setting section for setting an arbitrary  
5 point of the fingerprint-like pattern as a start point;

6 a reference-circle generation section for generating

7 a reference circle of a predetermined radius centered at the  
8 start point set by said start-point setting section;  
9 a reference-circle-intersecting-point calculation  
10 section for calculating intersecting points of the reference  
11 circle generated by said reference-circle generation section  
12 and the pattern curves of the fingerprint-like pattern;  
13 an intersecting-point extraction section for  
14 extracting those two of the intersecting points calculated  
15 by said reference-circle-intersecting-point calculation  
16 section which satisfy a predetermined condition;  
17 an end-point calculation section for calculating a  
18 middle point of the two intersecting points extracted by said  
19 intersecting-point extraction section as an end point; and  
20 a line-segment generation section for generating a  
21 line segment interconnecting the start point set by said  
22 start-point setting section and the end point calculated by  
23 said end-point calculation section;  
24 wherein said start-point setting section is operable  
25 to set the end point as a new start point so that said  
26 reference-circle generation section, said reference-  
27 circle-intersecting-point calculation section, said  
28 intersecting-point extraction section, said end-point  
29 calculation section and said line-segment generation section  
30 repeatedly generate a new line segment, thereby generating  
31 the auxiliary line as a number of successive line segments.

1 7. A pattern-center determination apparatus as

2 claimed in claim 1, wherein said auxiliary-line generation  
3 section includes:

4 a first-auxiliary-point setting section for setting  
5 two arbitrary points on an arbitrary one of pattern curves  
6 which form the fingerprint-like pattern as two first  
7 auxiliary points;

8 a start-point calculation section for calculating a  
9 middle point of the two first auxiliary points set by said  
10 first-auxiliary-point setting section as a start point;

11 an auxiliary-line-segment generation section for  
12 generating an auxiliary-line segment interconnecting the two  
13 first auxiliary points set by said first-auxiliary-point  
14 setting section;

15 a perpendicular-bisector generation section for  
16 generating a perpendicular bisector to the auxiliary-line  
17 segment generated by said auxiliary-line-segment generation  
18 section;

19 a perpendicular-bisector-intersecting-point  
20 calculation section for calculating that one of intersecting  
21 points of the perpendicular bisector generated by said  
22 perpendicular-bisector generation section and the pattern  
23 curves of the fingerprint-like pattern which is present on  
24 a particular side with respect to the start point and  
25 positioned nearest to the start point;

26 a node calculation section for calculating a point on  
27 the perpendicular bisector spaced by a predetermined  
28 distance toward the particular side from the intersecting

29 point calculated by said perpendicular-bisector-  
30 intersecting-point calculation section as a node;  
31 a straight-line generation section for generating a  
32 straight line which passes the node calculated by said node  
33 calculation section and intersects orthogonally with the  
34 perpendicular bisector;  
35 a second-auxiliary-point calculation section for  
36 calculating those two of intersecting points of the straight  
37 line generated by said straight-line generation section and  
38 the pattern curves of the fingerprint-like pattern which are  
39 on the opposite sides of the node and are positioned nearest  
40 to the node as second auxiliary points;  
41 an end-point calculation section for calculating a  
42 middle point of the two second auxiliary points calculated  
43 by said second-auxiliary-point calculation section as an end  
44 point;  
45 a first-line-segment generation section for  
46 generating a first line segment interconnecting the start  
47 point calculated by said start-point calculation section and  
48 the node calculated by said node calculation section; and  
49 a second-line-segment generation section for  
50 generating a second line segment interconnecting the node  
51 calculated by said node calculation section and the end point  
52 calculated by said end-point calculation section;  
53 wherein said first-auxiliary-point setting section is  
54 operable to set the two second auxiliary points as new first  
55 auxiliary points so that said start-point calculation

56 section, said auxiliary-line-segment generation section,  
57 said perpendicular-bisector generation section, said  
58 perpendicular-bisector-intersecting-point calculation  
59 section, said node calculation section, said straight-line  
60 generation section, said second-auxiliary-point calculation  
61 section, said end-point calculation section, said first-  
62 line-segment generation section and said second-line-  
63 segment generation section repeatedly generate new first and  
64 second line segments, thereby generating the auxiliary line  
65 as a number of alternately successive first and second line  
66 segments.

1 8. A pattern-center determination apparatus as  
2 claimed in claim 2, wherein said auxiliary-line generation  
3 section includes:

4 a first-auxiliary-point setting section for setting  
5 two arbitrary points on an arbitrary one of pattern curves  
6 which form the fingerprint-like pattern as two first  
7 auxiliary points;

8 a start-point calculation section for calculating a  
9 middle point of the two first auxiliary points set by said  
10 first-auxiliary-point setting section as a start point;

11 an auxiliary-line-segment generation section for  
12 generating an auxiliary-line segment interconnecting the two  
13 first auxiliary points set by said first-auxiliary-point  
14 setting section;

15 a perpendicular-bisector generation section for



16 generating a perpendicular bisector to the auxiliary-line  
17 segment generated by said auxiliary-line-segment generation  
18 section;

19 a perpendicular-bisector-intersecting-point  
20 calculation section for calculating that one of intersecting  
21 points of the perpendicular bisector generated by said  
22 perpendicular-bisector generation section and the pattern  
23 curves of the fingerprint-like pattern which is present on  
24 a particular side with respect to the start point and  
25 positioned nearest to the start point;

26 a node calculation section for calculating a point on  
27 the perpendicular bisector spaced by a predetermined  
28 distance toward the particular side from the intersecting  
29 point calculated by said perpendicular-bisector-  
30 intersecting-point calculation section as a node;

31 a straight-line generation section for generating a  
32 straight line which passes the node calculated by said node  
33 calculation section and intersects orthogonally with the  
34 perpendicular bisector;

35 a second-auxiliary-point calculation section for  
36 calculating those two of intersecting points of the straight  
37 line generated by said straight-line generation section and  
38 the pattern curves of the fingerprint-like pattern which are  
39 on the opposite sides of the node and are positioned nearest  
40 to the node as second auxiliary points;

41 an end-point calculation section for calculating a  
42 middle point of the two second auxiliary points calculated

43 by said second-auxiliary-point calculation section as an end  
44 point;

45 a first-line-segment generation section for  
46 generating a first line segment interconnecting the start  
47 point calculated by said start-point calculation section and  
48 the node calculated by said node calculation section; and

49 a second-line-segment generation section for  
50 generating a second line segment interconnecting the node  
51 calculated by said node calculation section and the end point  
52 calculated by said end-point calculation section;

53 wherein said first-auxiliary-point setting section is  
54 operable to set the two second auxiliary points as new first  
55 auxiliary points so that said start-point calculation  
56 section, said auxiliary-line-segment generation section,  
57 said perpendicular-bisector generation section, said  
58 perpendicular-bisector-intersecting-point calculation  
59 section, said node calculation section, said straight-line  
60 generation section, said second-auxiliary-point calculation  
61 section, said end-point calculation section, said first-  
62 line-segment generation section and said second-line-  
63 segment generation section repeatedly generate new first and  
64 second line segments, thereby generating the auxiliary line  
65 as a number of alternately successive first and second line  
66 segments.

1 9. A pattern-center determination apparatus as  
2 claimed in claim 3, wherein said auxiliary-line generation

3 section includes:

4 a first-auxiliary-point setting section for setting

5 two arbitrary points on an arbitrary one of pattern curves

6 which form the fingerprint-like pattern as two first

7 auxiliary points;

8 a start-point calculation section for calculating a

9 middle point of the two first auxiliary points set by said

10 first-auxiliary-point setting section as a start point;

11 an auxiliary-line-segment generation section for

12 generating an auxiliary-line segment interconnecting the two

13 first auxiliary points set by said first-auxiliary-point

14 setting section;

15 a perpendicular-bisector generation section for

16 generating a perpendicular bisector to the auxiliary-line

17 segment generated by said auxiliary-line-segment generation

18 section;

19 a perpendicular-bisector-intersecting-point

20 calculation section for calculating that one of intersecting

21 points of the perpendicular bisector generated by said

22 perpendicular-bisector generation section and the pattern

23 curves of the fingerprint-like pattern which is present on

24 a particular side with respect to the start point and

25 positioned nearest to the start point;

26 a node calculation section for calculating a point on

27 the perpendicular bisector spaced by a predetermined

28 distance toward the particular side from the intersecting

29 point calculated by said perpendicular-bisector-

30 intersecting-point calculation section as a node;

31 a straight-line generation section for generating a  
32 straight line which passes the node calculated by said node  
33 calculation section and intersects orthogonally with the  
34 perpendicular bisector;

35 a second-auxiliary-point calculation section for  
36 calculating those two of intersecting points of the straight  
37 line generated by said straight-line generation section and  
38 the pattern curves of the fingerprint-like pattern which are  
39 on the opposite sides of the node and are positioned nearest  
40 to the node as second auxiliary points;

41 an end-point calculation section for calculating a  
42 middle point of the two second auxiliary points calculated  
43 by said second-auxiliary-point calculation section as an end  
44 point;

45 a first-line-segment generation section for  
46 generating a first line segment interconnecting the start  
47 point calculated by said start-point calculation section and  
48 the node calculated by said node calculation section; and

49 a second-line-segment generation section for  
50 generating a second line segment interconnecting the node  
51 calculated by said node calculation section and the end point  
52 calculated by said end-point calculation section;

53 wherein said first-auxiliary-point setting section is  
54 operable to set the two second auxiliary points as new first  
55 auxiliary points so that said start-point calculation  
56 section, said auxiliary-line-segment generation section,

57 said perpendicular-bisector generation section, said  
58 perpendicular-bisector-intersecting-point calculation  
59 section, said node calculation section, said straight-line  
60 generation section, said second-auxiliary-point calculation  
61 section, said end-point calculation section, said first-  
62 line-segment generation section and said second-line-  
63 segment generation section repeatedly generate new first and  
64 second line segments, thereby generating the auxiliary line  
65 as a number of alternately successive first and second line  
66 segments.

1 10. A pattern-center determination apparatus as  
2 claimed in claim 1, wherein said auxiliary-line generation  
3 section includes:  
4 a start-point setting section for setting an arbitrary  
5 point on an arbitrary one of the pattern curves of the  
6 fingerprint-like pattern as a start point;  
7 an auxiliary-point calculation section for  
8 calculating two points positioned on the pattern curve on  
9 which the start point set by said start-point setting section  
10 is present and spaced by a predetermined distance from the  
11 start point to the opposite sides along the pattern curve  
12 as auxiliary points;  
13 an auxiliary-line-segment generation section for  
14 generating an auxiliary-line segment interconnecting the two  
15 auxiliary points calculated by said auxiliary-point  
16 calculation section;

17           a straight-line generation section for generating a  
18       straight line which passes the start point set by said  
19       start-point setting section and intersects orthogonally with  
20       the auxiliary-line segment generated by said auxiliary-  
21       line-segment generation section;

22           an end-point calculation section for calculating that  
23       one of intersecting points of the straight line generated  
24       by said straight-line generation section and the pattern  
25       curves of the fingerprint-like pattern which is positioned  
26       on a particular side with respect to the start point and  
27       nearest to the start point as an end point; and

28           a line-segment generation section for generating a  
29       line segment interconnecting the start point set by said  
30       start-point setting section and the end point calculated by  
31       said end-point calculation section;

32           wherein said start-point setting section is operable  
33       to set the end point as a new start point so that said  
34       auxiliary-point calculation section, said auxiliary-  
35       line-segment generation section, said straight-line  
36       generation section, said end-point calculation section and  
37       said line-segment generation section repeatedly generate a  
38       new line segment, thereby generating the auxiliary line as  
39       a number of successive line segments.

1           11.   A pattern-center determination apparatus as  
2       claimed in claim 2, wherein said auxiliary-line generation  
3       section includes:

4           a start-point setting section for setting an arbitrary  
5 point on an arbitrary one of the pattern curves of the  
6 fingerprint-like pattern as a start point;  
7           an auxiliary-point calculation section for  
8 calculating two points positioned on the pattern curve on  
9 which the start point set by said start-point setting section  
10 is present and spaced by a predetermined distance from the  
11 start point to the opposite sides along the pattern curve  
12 as auxiliary points;  
13          an auxiliary-line-segment generation section for  
14 generating an auxiliary-line segment interconnecting the two  
15 auxiliary points calculated by said auxiliary-point  
16 calculation section;  
17          a straight-line generation section for generating a  
18 straight line which passes the start point set by said  
19 start-point setting section and intersects orthogonally with  
20 the auxiliary-line segment generated by said auxiliary-  
21 line-segment generation section;  
22          an end-point calculation section for calculating that  
23 one of intersecting points of the straight line generated  
24 by said straight-line generation section and the pattern  
25 curves of the fingerprint-like pattern which is positioned  
26 on a particular side with respect to the start point and  
27 nearest to the start point as an end point; and  
28          a line-segment generation section for generating a  
29 line segment interconnecting the start point set by said  
30 start-point setting section and the end point calculated by

31 said end-point calculation section;  
32 wherein said start-point setting section is operable  
33 to set the end point as a new start point so that said  
34 auxiliary-point calculation section, said auxiliary-  
35 line-segment generation section, said straight-line  
36 generation section, said end-point calculation section and  
37 said line-segment generation section repeatedly generate a  
38 new line segment, thereby generating the auxiliary line as  
39 a number of successive line segments.

1 12. A pattern-center determination apparatus as  
2 claimed in claim 3, wherein said auxiliary-line generation  
3 section includes:

4 a start-point setting section for setting an arbitrary  
5 point on an arbitrary one of the pattern curves of the  
6 fingerprint-like pattern as a start point;

7 an auxiliary-point calculation section for  
8 calculating two points positioned on the pattern curve on  
9 which the start point set by said start-point setting section  
10 is present and spaced by a predetermined distance from the  
11 start point to the opposite sides along the pattern curve  
12 as auxiliary points;

13 an auxiliary-line-segment generation section for  
14 generating an auxiliary-line segment interconnecting the two  
15 auxiliary points calculated by said auxiliary-point  
16 calculation section;

17 a straight-line generation section for generating a



18 straight line which passes the start point set by said  
19 start-point setting section and intersects orthogonally with  
20 the auxiliary-line segment generated by said auxiliary-  
21 line-segment generation section;

22 an end-point calculation section for calculating that  
23 one of intersecting points of the straight line generated  
24 by said straight-line generation section and the pattern  
25 curves of the fingerprint-like pattern which is positioned  
26 on a particular side with respect to the start point and  
27 nearest to the start point as an end point; and

28 a line-segment generation section for generating a  
29 line segment interconnecting the start point set by said  
30 start-point setting section and the end point calculated by  
31 said end-point calculation section;

32 wherein said start-point setting section is operable  
33 to set the end point as a new start point so that said  
34 auxiliary-point calculation section, said auxiliary-  
35 line-segment generation section, said straight-line  
36 generation section, said end-point calculation section and  
37 said line-segment generation section repeatedly generate a  
38 new line segment, thereby generating the auxiliary line as  
39 a number of successive line segments.

1 13. A pattern-center determination method for  
2 determining a pattern center of a fingerprint-like pattern,  
3 which is formed with a number of pattern curves, said method  
4 comprising the steps of:

5           generating two or more auxiliary lines extending  
6 continuously from an outer circumference side one of the  
7 pattern curves of the fingerprint-like pattern toward an  
8 inner circumference side one of the pattern curves so that  
9 each of the two or more auxiliary lines intersects each of  
10 the pattern curves perpendicularly or substantially  
11 perpendicularly; and  
12           determining the pattern center based on one or more  
13 intersecting points of the two or more auxiliary lines.

1           14.   A computer-readable recording medium on which  
2 a pattern-center determination program is recorded for use  
3 with a computer, said program being for determining a pattern  
4 center of a fingerprint-like pattern, which is formed with  
5 a number of pattern curves, and instructing the computer to  
6 function as:

7           an auxiliary-line generation section for generating  
8 two or more auxiliary lines extending continuously from an  
9 outer circumference side one of the pattern curves of the  
10 fingerprint-like pattern toward an inner circumference side  
11 one of the pattern curves so that each of the two or more  
12 auxiliary lines intersects each of the pattern curves  
13 perpendicularly or substantially perpendicularly; and

14           a pattern-center determination section for  
15 determining the pattern center based on one or more  
16 intersecting points of the two or more auxiliary lines  
17 generated by said auxiliary-line generation section.

1           15.    A pattern-orientation determination apparatus  
2   for determining a pattern orientation of a fingerprint-like  
3   pattern, which is formed with a number of pattern curves,  
4   said apparatus comprising:  
5           a pattern-center determination section for  
6   determining a pattern center of the fingerprint-like  
7   pattern;  
8           a reference-circle generation section for generating  
9   a reference circle of a predetermined radius centered at the  
10   pattern center determined by said pattern-center  
11   determination section;  
12           a reference-circle-intersecting-point calculation  
13   section for calculating intersecting points of the reference  
14   circle generated by said reference-circle generation section  
15   and the pattern curves of the fingerprint-like pattern;  
16           a reference-point determination section for  
17   determining a reference point for the pattern orientation  
18   based on a relationship between directions of the reference  
19   circle and directions of the pattern curves at the  
20   intersecting points calculated by said reference-circle-  
21   intersecting-point calculation section; and  
22           a pattern-orientation determination section for  
23   determining the pattern orientation based on the pattern  
24   center determined by said pattern-center determination  
25   section and the reference point determined by said  
26   reference-point determination section.

1           16.    A pattern-orientation determination apparatus  
2           as claimed in claim 15, wherein said reference-point  
3           determination section includes:  
4                an intersecting-point extraction section for  
5           extracting those two of the intersecting points calculated  
6           by said reference-circle-intersecting-point calculation  
7           section which satisfy a predetermined condition; and  
8                a reference-point calculation section for calculating  
9           a middle point of the two intersecting points extracted by  
10          said intersecting-point extraction section as the reference  
11          point.

1           17.    A pattern-orientation determination apparatus  
2           as claimed in claim 15, wherein said pattern-orientation  
3           determination section includes a rectification section for  
4           rectifying the position of the pattern center based on those  
5           of the pattern curves which are present in the proximity of  
6           the pattern center, and said pattern-orientation  
7           determination section is operable to determine the direction  
8           of a reference straight line which passes the position of  
9           the pattern center rectified by said rectification section  
10          and the reference point as the pattern orientation.

1           18.    A pattern-orientation determination apparatus  
2           as claimed in claim 16, wherein said pattern-orientation  
3           determination section includes a rectification section for

4 rectifying the position of the pattern center based on those  
5 of the pattern curves which are present in the proximity of  
6 the pattern center, and said pattern-orientation  
7 determination section is operable to determine the direction  
8 of a reference straight line which passes the position of  
9 the pattern center rectified by said rectification section  
10 and the reference point as the pattern orientation.

1 19. A pattern-orientation determination apparatus  
2 according to claim 15, wherein said pattern-orientation  
3 determination section is operable to determine the direction  
4 of a reference straight line which passes the pattern center  
5 and the reference point as the pattern orientation.

1 20. A pattern-orientation determination apparatus  
2 according to claim 16, wherein said pattern-orientation  
3 determination section is operable to determine the direction  
4 of a reference straight line which passes the pattern center  
5 and the reference point as the pattern orientation.

1 21. A pattern-orientation determination apparatus  
2 according to claim 15, wherein said pattern-center  
3 determination section includes:

4 an auxiliary-line generation section for generating  
5 two or more auxiliary lines extending continuously from an  
6 outer circumference side one of the pattern curves of the  
7 fingerprint-like pattern toward an inner circumference side

8 one of the pattern curves so that each of the auxiliary lines  
9 intersects each of the pattern curves perpendicularly or  
10 substantially perpendicularly; and  
11 a pattern-center determination section for  
12 determining the pattern center based on one or more  
13 intersecting points of the two or more auxiliary lines  
14 generated by said auxiliary-line generation section.

1 22. A pattern-orientation determination apparatus  
2 according to claim 16, wherein said pattern-center  
3 determination section includes:

4 an auxiliary-line generation section for generating  
5 two or more auxiliary lines extending continuously from an  
6 outer circumference side one of the pattern curves of the  
7 fingerprint-like pattern toward an inner circumference side  
8 one of the pattern curves so that each of the auxiliary lines  
9 intersects each of the pattern curves perpendicularly or  
10 substantially perpendicularly; and

11 a pattern-center determination section for  
12 determining the pattern center based on one or more  
13 intersecting points of the two or more auxiliary lines  
14 generated by said auxiliary-line generation section.

1 23. A pattern-orientation determination apparatus  
2 according to claim 17, wherein said pattern-center  
3 determination section includes:

4 an auxiliary-line generation section for generating

5 two or more auxiliary lines extending continuously from an  
6 outer circumference side one of the pattern curves of the  
7 fingerprint-like pattern toward an inner circumference side  
8 one of the pattern curves so that each of the auxiliary lines  
9 intersects each of the pattern curves perpendicularly or  
10 substantially perpendicularly; and

11 a pattern-center determination section for  
12 determining the pattern center based on one or more  
13 intersecting points of the two or more auxiliary lines  
14 generated by said auxiliary-line generation section.

1 24. A pattern-orientation determination apparatus  
2 according to claim 18, wherein said pattern-center  
3 determination section includes:

4 an auxiliary-line generation section for generating  
5 two or more auxiliary lines extending continuously from an  
6 outer circumference side one of the pattern curves of the  
7 fingerprint-like pattern toward an inner circumference side  
8 one of the pattern curves so that each of the auxiliary lines  
9 intersects each of the pattern curves perpendicularly or  
10 substantially perpendicularly; and

11 a pattern-center determination section for  
12 determining the pattern center based on one or more  
13 intersecting points of the two or more auxiliary lines  
14 generated by said auxiliary-line generation section.

1 25. A pattern-orientation determination apparatus

2 according to claim 19, wherein said pattern-center  
3 determination section includes:

4 an auxiliary-line generation section for generating  
5 two or more auxiliary lines extending continuously from an  
6 outer circumference side one of the pattern curves of the  
7 fingerprint-like pattern toward an inner circumference side  
8 one of the pattern curves so that each of the auxiliary lines  
9 intersects each of the pattern curves perpendicularly or  
10 substantially perpendicularly; and

11 a pattern-center determination section for  
12 determining the pattern center based on one or more  
13 intersecting points of the two or more auxiliary lines  
14 generated by said auxiliary-line generation section.

1 26. A pattern-orientation determination apparatus  
2 according to claim 20, wherein said pattern-center  
3 determination section includes:

4 an auxiliary-line generation section for generating  
5 two or more auxiliary lines extending continuously from an  
6 outer circumference side one of the pattern curves of the  
7 fingerprint-like pattern toward an inner circumference side  
8 one of the pattern curves so that each of the auxiliary lines  
9 intersects each of the pattern curves perpendicularly or  
10 substantially perpendicularly; and

11 a pattern-center determination section for  
12 determining the pattern center based on one or more  
13 intersecting points of the two or more auxiliary lines



14 generated by said auxiliary-line generation section.

1 27. A pattern-orientation determination method for  
2 determining a pattern orientation of a fingerprint-like  
3 pattern, which is formed with a number of pattern curves,  
4 said method comprising the steps of:

5 determining a pattern center of the fingerprint-like  
6 pattern;

7 generating a reference circle of a predetermined  
8 radius centered at the pattern center;

9 calculating intersecting points of the reference  
10 circle and the pattern curves of the fingerprint-like  
11 pattern;

12 determining a reference point for the pattern  
13 orientation based on a relationship between directions of  
14 the reference circle and directions of the pattern curves  
15 at the calculated intersecting points; and

16 determining the pattern orientation based on the  
17 pattern center and the reference point.

1 28. A computer-readable recording medium on which  
2 a pattern-orientation determination program is recorded for  
3 use with a computer, said program being for determining a  
4 pattern orientation of a fingerprint-like pattern, which is  
5 formed with a number of pattern curves, and instructing the  
6 computer to function as:

7 a pattern-center determination section for

8 determining a pattern center of the fingerprint-like  
9 pattern;  
10 a reference-circle generation section for generating  
11 a reference circle of a predetermined radius centered at the  
12 pattern center determined by said pattern-center  
13 determination section;  
14 a reference-circle-intersecting-point calculation  
15 section for calculating intersecting points of the reference  
16 circle generated by said reference-circle generation section  
17 and the pattern curves of the fingerprint-like pattern;  
18 a reference-point determination section for  
19 determining a reference point for the pattern orientation  
20 based on a relationship between directions of the reference  
21 circle and directions of the pattern curves at the  
22 intersecting points calculated by said reference-circle-  
23 intersecting-point calculation section; and  
24 a pattern-orientation determination section for  
25 determining the pattern orientation based on the pattern  
26 center determined by said pattern-center determination  
27 section and the reference point determined by said  
28 reference-point determination section.

1 29. A pattern alignment apparatus for aligning two  
2 fingerprint-like patterns, each of which is formed with a  
3 number of pattern curves, said apparatus comprising:  
4 an alignment-reference determination section for  
5 determining one or more alignment references for each of the

6 fingerprint-like patterns; and  
7 an alignment section for aligning the two  
8 fingerprint-like patterns so that the alignment references  
9 of the two fingerprint-like patterns determined by said  
10 alignment-reference determination section coincide with  
11 each other;  
12 said alignment-reference determination section  
13 including a pattern-center determination section for  
14 determining a pattern center of each of the fingerprint-  
15 like patterns as one of the alignment references, said  
16 pattern-center determination section having  
17 an auxiliary-line generation section for  
18 generating two or more auxiliary lines extending  
19 continuously from an outer circumference side one of the  
20 pattern curves of each said fingerprint-like pattern toward  
21 an inner circumference side one of the pattern curves so that  
22 each of the auxiliary lines intersects each of the pattern  
23 curves perpendicularly or substantially perpendicularly,  
24 and  
25 a pattern-center determination section for  
26 determining the pattern center based on one or more  
27 intersecting points of the two or more auxiliary lines  
28 generated by said auxiliary-line generation section.

1 30. A pattern alignment apparatus as claimed in  
2 claim 29, wherein said alignment-reference determination  
3 section further includes a pattern-orientation

4 determination section for determining a pattern orientation  
5 of each of the fingerprint-like patterns as one of the  
6 alignment references, said pattern-orientation  
7 determination section having:  
8 a reference-circle generation section for generating  
9 a reference circle of a predetermined radius centered at the  
10 pattern center determined by said pattern-center  
11 determination section;  
12 a reference-circle-intersecting-point calculation  
13 section for calculating intersecting points of the reference  
14 circle generated by said reference-circle generation section  
15 and the pattern curves of the fingerprint-like pattern;  
16 a reference-point determination section for  
17 determining a reference point for the pattern orientation  
18 based on a relationship between directions of the reference  
19 circle and directions of the pattern curves at the  
20 intersecting points calculated by said reference-circle-  
21 intersecting-point calculation section; and  
22 a pattern-orientation determination section for  
23 determining the pattern orientation based on the pattern  
24 center determined by said pattern-center determination  
25 section and the reference point determined by said  
26 reference-point determination section.

1 31. A pattern alignment apparatus for aligning two  
2 fingerprint-like patterns, each of which is formed with a  
3 number of pattern curves, said apparatus comprising:

4           an alignment-reference determination section for  
5     determining one or more alignment references for each of the  
6     fingerprint-like patterns; and  
7           an alignment section for aligning the two  
8     fingerprint-like patterns so that the alignment references  
9     of the two fingerprint-like patterns determined by said  
10    alignment-reference determination section coincide with  
11    each other;  
12           said alignment-reference determination section  
13    including a pattern-orientation determination section for  
14    determining a pattern orientation of each of the  
15    fingerprint-like patterns as one of the alignment references,  
16    said pattern-orientation determination section having  
17           a pattern-center determination section for  
18    determining a pattern center of each said fingerprint-like  
19    patterns as the alignment reference,  
20           a reference-circle generation section for  
21    generating a reference circle of a predetermined radius  
22    centered at the pattern center determined by said  
23    pattern-center determination section,  
24           a reference-circle-intersecting-point  
25    calculation section for calculating intersecting points of  
26    the reference circle generated by said reference-circle  
27    generation section and the pattern curves of each said  
28    fingerprint-like pattern,  
29           a reference-point determination section for  
30    determining a reference point for the pattern orientation

31 based on a relationship between directions of the reference  
32 circle and directions of the pattern curves at the  
33 intersecting points calculated by said reference-circle-  
34 intersecting-point calculation section, and  
35 a pattern-orientation determination section for  
36 determining the pattern orientation based on the pattern  
37 center determined by said pattern-center determination  
38 section and the reference point determined by said  
39 reference-point determination section.

1 32. A pattern alignment apparatus as claimed in  
2 claim 29, further comprising:  
3 a minutia extraction section for extracting a group  
4 of minutiae from each of the two fingerprint-like patterns;  
5 a collation section for collating the two group of  
6 minutiae extracted from the two fingerprint-like patterns  
7 by said minutia extraction section based on the alignment  
8 by said alignment section;  
9 an adjustment-shift calculation section for  
10 calculating an adjustment shift of at least one of the two  
11 fingerprint-like patterns based on a result of the collation  
12 by said collation section so that the alignment of the two  
13 fingerprint-like patterns is improved; and  
14 a alignment-result adjustment section for shifting at  
15 least one of the two fingerprint-like patterns by the  
16 adjustment shift calculated by said adjustment-shift  
17 calculation section so as to adjust a result of the alignment

18 by said alignment section.

1 33. A pattern alignment apparatus as claimed in  
2 claim 30, further comprising:

3 a minugia extraction section for extracting a group  
4 of minugia from each of the two fingerprint-like patterns;

5 a collation section for collating the two group of  
6 minugia extracted from the two fingerprint-like patterns  
7 by said minugia extraction section based on the alignment  
8 by said alignment section;

9 an adjustment-shift calculation section for  
10 calculating an adjustment shift of at least one of the two  
11 fingerprint-like patterns based on a result of the collation  
12 by said collation section so that the alignment of the two  
13 fingerprint-like patterns is improved; and

14 a alignment-result adjustment section for shifting at  
15 least one of the two fingerprint-like patterns by the  
16 adjustment shift calculated by said adjustment-shift  
17 calculation section so as to adjust a result of the alignment  
18 by said alignment section.

1 34. A pattern alignment apparatus as claimed in  
2 claim 31, further comprising:

3 a minugia extraction section for extracting a group  
4 of minugia from each of the fingerprint-like patterns;

5 a collation section for collating the two group of  
6 minugia extracted from the two fingerprint-like patterns

7 by said minutia extraction section based on the alignment  
8 by said alignment section;

9 an adjustment-shift calculation section for  
10 calculating an adjustment shift of at least one of the two  
11 fingerprint-like patterns based on a result of the collation  
12 by said collation section so that the alignment of the two  
13 fingerprint-like patterns is improved; and

14 a alignment-result adjustment section for shifting at  
15 least one of the two fingerprint-like patterns by the  
16 adjustment shift calculated by said adjustment-shift  
17 calculation section so as to adjust a result of the alignment  
18 by said alignment section.

1 35. A pattern alignment apparatus as claimed in  
2 claim 32, wherein the adjustment shift is at least one of  
3 a rotation angle by which one of the two fingerprint-like  
4 patterns is to be rotated around a predetermined point with  
5 respect to the other of the two fingerprint-like patterns  
6 and a shift by which one of the two fingerprint-like patterns  
7 is to be parallelly shifted with respect to the other of the  
8 two fingerprint-like patterns.

1 36. A pattern alignment apparatus as claimed in  
2 claim 33, wherein the adjustment shift is at least one of  
3 a rotation angle by which one of the two fingerprint-like  
4 patterns is to be rotated around a predetermined point with  
5 respect to the other of the two fingerprint-like patterns



6 and a shift by which one of the two fingerprint-like patterns  
7 is to be parallelly shifted with respect to the other of the  
8 two fingerprint-like patterns.

1 37. A pattern alignment apparatus as claimed in  
2 claim 34, wherein the adjustment shift is at least one of  
3 a rotation angle by which one of the two fingerprint-like  
4 patterns is to be rotated around a predetermined point with  
5 respect to the other of the two fingerprint-like patterns  
6 and a shift by which one of the two fingerprint-like patterns  
7 is to be parallelly shifted with respect to the other of the  
8 two fingerprint-like patterns.

1 38. A pattern verification apparatus for verifying  
2 a group of object minutiae for verification extracted from  
3 an object fingerprint-like pattern for verification with a  
4 group of registered minutiae extracted in advance from a  
5 registered fingerprint-like pattern, each of the object  
6 fingerprint-like pattern and the registered fingerprint-  
7 like pattern being formed with the number of pattern curves,  
8 said apparatus comprising:  
9 a pattern inputting section for inputting the object  
10 fingerprint-like pattern;  
11 an alignment-reference determination section for  
12 determining one or more alignment references of the object  
13 fingerprint-like pattern inputted by said pattern inputting  
14 section;

15 a minutia extraction section for extracting the group  
16 of object minutiae from the object fingerprint-like pattern  
17 inputted by said pattern inputting section;

18 a registration-data obtaining section for obtaining  
19 registration data regarding the registered fingerprint-like  
20 pattern, said registration data including the group of  
21 registered minutiae and one or more alignment references of  
22 the registered fingerprint-like pattern;

23 an alignment section for aligning the object  
24 fingerprint-like pattern or the group of object minutiae and  
25 the group of registered minutiae so that the alignment  
26 references of the object fingerprint-like pattern determined  
27 by said alignment-reference determination section and the  
28 alignment references of the registered fingerprint-like  
29 pattern obtained by said registration-data obtaining section  
30 coincide with each other; and

31 a verification section for verifying the group of  
32 object minutiae with the group of registered minutiae based  
33 on the alignment by said alignment section;

34 said alignment-reference determination section  
35 including a pattern-center determination section for  
36 determining a pattern center of the object fingerprint-like  
37 pattern as one of the alignment references of the object  
38 fingerprint-like pattern,

39 the alignment references of the registered  
40 fingerprint-like pattern including a pattern center of the  
41 registered fingerprint-like pattern;

42           said pattern-center determination section including  
43           an auxiliary-line generation section for  
44       generating two or more auxiliary lines extending  
45       continuously from an outer circumference side one of the  
46       pattern curves of the fingerprint-like pattern toward an  
47       inner circumference side one of the pattern curves so that  
48       each of the auxiliary lines intersects each of the pattern  
49       curves perpendicularly or substantially perpendicularly,  
50       and  
51           a pattern-center determination section for  
52       determining the pattern center based on one or more  
53       intersecting points of the two or more auxiliary lines  
54       generated by said auxiliary-line generation section.

1           39.   A pattern verification apparatus as claimed in  
2       claim 38, wherein  
3           said alignment-reference determination section  
4       further includes a pattern-orientation determination  
5       section for determining a pattern orientation of the  
6       fingerprint-like pattern for verification as one of the  
7       alignment references,  
8           the alignment references of the registered  
9       fingerprint-like pattern including a pattern orientation of  
10      the registered fingerprint-like pattern, and  
11      said pattern-orientation determination section  
12      includes  
13      a reference-circle generation section for

14 generating a reference circle of a predetermined radius  
15 centered at the pattern center determined by said  
16 pattern-center determination section,  
17 a reference-circle-intersecting-point  
18 calculation section for calculating intersecting points of  
19 the reference circle generated by said reference-circle  
20 generation section and the pattern curves of the registered  
21 fingerprint-like pattern,  
22 a reference-point determination section for  
23 determining a reference point for the pattern orientation  
24 based on a relationship between directions of the reference  
25 circle and directions of the pattern curves at the  
26 intersecting points calculated by said reference-circle-  
27 intersecting-point calculation section, and  
28 a pattern-orientation determination section for  
29 determining the pattern orientation based on the pattern  
30 center determined by said pattern-center determination  
31 section and the reference point determined by said  
32 reference-point determination section.

1 40. A pattern verification apparatus for verifying  
2 a group of object minutiae extracted from an object  
3 fingerprint-like pattern for verification with a group of  
4 registered minutiae extracted in advance from a registered  
5 fingerprint-like pattern, each of the object  
6 fingerprint-like pattern and the registered fingerprint-  
7 like pattern being formed with the number of pattern curves,

8       said apparatus comprising:

9             a pattern inputting section for inputting the object

10       fingerprint-like pattern;

11             an alignment-reference determination section for

12       determining one or more alignment references of the object

13       fingerprint-like pattern inputted by said pattern inputting

14       section;

15             a minutia extraction section for extracting the group

16       of object minutiae from the object fingerprint-like pattern

17       inputted by said pattern inputting section;

18             a registration-data obtaining section for obtaining

19       registration data regarding the registered fingerprint-like

20       pattern, said registration data including the group of

21       registered minutiae and one or more alignment references of

22       the registered fingerprint-like pattern;

23             an alignment section for aligning the object

24       fingerprint-like pattern or the group of object minutiae and

25       the group of registered minutiae so that the alignment

26       references of the object fingerprint-like pattern determined

27       by said alignment-reference determination section and the

28       alignment references of the registered fingerprint-like

29       pattern obtained by said registration-data obtaining section

30       coincide with each other; and

31             a verification section for verifying the group of

32       object minutiae with the group of registered minutiae based

33       on the alignment by said alignment section;

34             said alignment-reference determination section

35 including a pattern-orientation determination section for  
36 determining a pattern orientation of the object  
37 fingerprint-like pattern as one of the alignment references,  
38 the registered alignment references of the registered  
39 fingerprint-like pattern including a pattern orientation of  
40 the registered fingerprint-like pattern;  
41 said pattern-orientation determination section  
42 including  
43 a pattern-center determination section for  
44 determining a pattern center of the object fingerprint-like  
45 pattern,  
46 a reference-circle generation section for  
47 generating a reference circle of a predetermined radius  
48 centered at the pattern center of the object fingerprint-like  
49 pattern determined by said pattern-center determination  
50 section,  
51 a reference-circle-intersecting-point  
52 calculation section for calculating intersecting points of  
53 the reference circle generated by said reference-circle  
54 generation section and the pattern curves of the object  
55 fingerprint-like pattern,  
56 a reference-point determination section for  
57 determining a reference point for the pattern orientation  
58 based on a relationship between directions of the reference  
59 circle and directions of the pattern curves at the  
60 intersecting points calculated by said reference-circle-  
61 intersecting-point calculation section, and

62                   a pattern-orientation determination section for  
63 determining the pattern orientation based on the pattern  
64 center determined by said pattern-center determination  
65 section and the reference point determined by said  
66 reference-point determination section.

1           41.   A pattern verification apparatus as claimed in  
2 claim 38, wherein said pattern inputting section is operable  
3 to input the registered fingerprint-like pattern, said  
4 alignment-reference determination section is operable to  
5 determine the alignment references of the registered  
6 fingerprint-like pattern inputted by said pattern inputting  
7 section, said minutia extraction section is operable to  
8 extract the group of registered minutiae from the registered  
9 fingerprint-like pattern inputted by said pattern inputting  
10 section, and said registration-data obtaining section is  
11 operable to obtain both the alignment references of the  
12 registered fingerprint-like pattern determined by said  
13 alignment-reference determination section and the group of  
14 registered minutiae extracted by said minutia extraction  
15 section as the registration data regarding the registered  
16 fingerprint-like pattern.

1           42.   A pattern verification apparatus as claimed in  
2 claim 39, wherein said pattern inputting section is operable  
3 to input the registered fingerprint-like pattern, said  
4 alignment-reference determination section is operable to

5 determine the alignment references of the registered  
6 fingerprint-like pattern inputted by said pattern inputting  
7 section, said minutia extraction section is operable to  
8 extract the group of registered minutiae from the registered  
9 fingerprint-like pattern inputted by said pattern inputting  
10 section, and said registration-data obtaining section is  
11 operable to obtain both the alignment references of the  
12 registered fingerprint-like pattern determined by said  
13 alignment-reference determination section and the group of  
14 registered minutiae extracted by said minutia extraction  
15 section as the registration data regarding the registered  
16 fingerprint-like pattern.

1 43. A pattern verification apparatus as claimed in  
2 claim 40, wherein said pattern inputting section is operable  
3 to input the registered fingerprint-like pattern, said  
4 alignment-reference determination section is operable to  
5 determine the alignment references of the registered  
6 fingerprint-like pattern inputted by said pattern inputting  
7 section, said minutia extraction section is operable to  
8 extract the group of registered minutiae from the registered  
9 fingerprint-like pattern inputted by said pattern inputting  
10 section, and said registration-data obtaining section is  
11 operable to obtain both the alignment references of the  
12 registered fingerprint-like pattern determined by said  
13 alignment-reference determination section and the group of  
14 registered minutiae extracted by said minutia extraction



15 section as the registration data regarding the registered  
16 fingerprint-like pattern.

1 44. A pattern verification apparatus as claimed in  
2 claim 38, further comprising:

3 an adjustment-shift calculation section for  
4 calculating an adjustment shift of the group of object  
5 minutiae or/and the group of registered minutiae based on  
6 a result of the verification by said verification section  
7 so that the alignment of the group of object minutiae and  
8 the group of registered minutiae is improved; and

9 an alignment-result adjustment section for shifting  
10 the group of object minutiae or/and the group of registered  
11 minutiae by the adjustment shift calculated by said  
12 adjustment-shift calculation section so as to adjusting a  
13 result of the alignment by said alignment section;

14 said verification section being operable to output a  
15 result of the verification between the group of object  
16 minutiae and the group of registered minutiae based on the  
17 adjustment of the alignment result by said alignment-result  
18 adjustment section.

1 45. A pattern verification apparatus as claimed in  
2 claim 39, further comprising:

3 an adjustment-shift calculation section for  
4 calculating an adjustment shift of the group of object  
5 minutiae or/and the group of registered minutiae based on

6 a result of the verification by said verification section  
7 so that the alignment of the group of object minutiae and  
8 the group of registered minutiae is improved; and  
9 an alignment-result adjustment section for shifting  
10 the group of object minutiae or/and the group of registered  
11 minutiae by the adjustment shift calculated by said  
12 adjustment-shift calculation section so as to adjust a result  
13 of the alignment by said alignment section;  
14 said verification section being operable to output a  
15 result of the verification between the group of object  
16 minutiae and the group of registered minutiae based on the  
17 adjustment of the alignment by said alignment-result  
18 adjustment section.

1 46. A pattern verification apparatus as claimed in  
2 claim 40, further comprising:  
3 an adjustment-shift calculation section for  
4 calculating an adjustment shift of the group of object  
5 minutiae or/and the group of registered minutiae based on  
6 a result of the verification by said verification section  
7 so that the alignment of the group of object minutiae and  
8 the group of registered minutiae is improved; and  
9 an alignment-result adjustment section for shifting  
10 the group of object minutiae or/and the group of registered  
11 minutiae by the adjustment shift calculated by said  
12 adjustment-shift calculation section so as to adjust a result  
13 of the alignment by said alignment section;

14           said verification section being operable to output a  
15   result of the verification between the group of object  
16   minutiae and the group of registered minutiae based on the  
17   adjustment of the alignment by said alignment-result  
18   adjustment section.

1           47.   A pattern verification apparatus as claimed in  
2   claim 44, wherein the adjustment shift is at least one of  
3   a rotation angle by which at least one of the group of object  
4   minutiae and the group of registered minutiae are to be  
5   rotated around a predetermined point with respect to the  
6   other of the two groups of minutiae and a shift by which at  
7   least one of the group of object minutiae and the group of  
8   registered minutiae are to be parallelly shifted with respect  
9   to the other of the two groups of minutiae.

1           48.   A pattern verification apparatus as claimed in  
2   claim 45, wherein the adjustment shift is at least one of  
3   a rotation angle by which at least one of the group of object  
4   minutiae and the group of registered minutiae are to be  
5   rotated around a predetermined point with respect to the  
6   other of the two groups of minutiae and a shift by which at  
7   least one of the group of object minutiae and the group of  
8   registered minutiae are to be parallelly shifted with respect  
9   to the other of the two groups of minutiae.

1           49.   A pattern verification apparatus as claimed in

2 claim 46, wherein the adjustment shift is at least one of  
3 a rotation angle by which at least one of the group of object  
4 minutiae and the group of registered minutiae are to be  
5 rotated around a predetermined point with respect to the  
6 other of the two groups of minutiae and a shift by which at  
7 least one of the group of object minutiae and the group of  
8 registered minutiae are to be parallelly shifted with respect  
9 to the other of the two groups of minutiae.

1 50. A pattern alignment apparatus for aligning two  
2 fingerprint-like patterns, each of which is formed with a  
3 number of pattern curves, while adjusting the alignment of  
4 the two fingerprint-like patterns, comprising:  
5 an alignment section for aligning the two  
6 fingerprint-like patterns;  
7 a minutia extraction section for extracting a group  
8 of minutiae from each of the fingerprint-like patterns;  
9 a collation section for collating the two group of  
10 minutiae extracted from the two fingerprint-like patterns  
11 by said minutia extraction section based on the alignment  
12 by said alignment section;  
13 an adjustment-shift calculation section for  
14 calculating an adjustment shift by which at least one of the  
15 two fingerprint-like patterns is to be shifted for adjusting  
16 the alignment of the two fingerprint-like patterns, based  
17 on a result of the collation by said collation section so  
18 that the alignment of the two fingerprint-like patterns is

19 improved; and  
20 an alignment-result adjustment section for shifting  
21 at least one of the two fingerprint-like patterns by the  
22 adjustment shift calculated by said adjustment-shift  
23 calculation section so as to adjust a result of the alignment  
24 by said alignment section.

1 51. A pattern alignment apparatus as claimed in  
2 claim 50, further comprising  
3 a permissible-shift-range calculation section for  
4 calculating a permissible shift range, said permissible  
5 shift range being a shift range within which, when said  
6 collation section has discriminated that one or more minutiae  
7 of one of the two fingerprint-like patterns coincide with  
8 one or more minutiae of the other of the two fingerprint-like  
9 patterns respectively, one of the two fingerprint-like  
10 patterns can be shifted with respect to the other of the two  
11 fingerprint-like patterns while at least some of the one or  
12 more pairs of coinciding minutiae maintain the coincidence  
13 relationship,  
14 said adjustment-shift calculation section being  
15 operable to calculate the adjustment shift within the  
16 permissible shift range calculated by said permissible-  
17 shift-range calculation section.

1 52. A pattern alignment apparatus as claimed in  
2 claim 50, wherein the adjustment shift is at least one of

3 a rotation angle by which one of the two fingerprint-like  
4 patterns is to be rotated around a predetermined point with  
5 respect to the other of the two fingerprint-like patterns  
6 and a shift by which one of the two fingerprint-like patterns  
7 is to be parallelly shifted with respect to the other of the  
8 two fingerprint-like patterns.

1 53. A pattern alignment apparatus as claimed in  
2 claim 51, wherein the adjustment shift is at least one of  
3 a rotation angle by which one of the two fingerprint-like  
4 patterns is to be rotated around a predetermined point with  
5 respect to the other of the two fingerprint-like patterns  
6 and a shift by which one of the two fingerprint-like patterns  
7 is to be parallelly shifted with respect to the other of the  
8 two fingerprint-like patterns.